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COMMENTARY ON INDIAN STANDARD SCHEDULES FOR WROUGHT STEELS

PART 1 STEELS SPECIFIED BY TENSILE AND/OR YIELD PROPERTIES [COMPLEMENTARY TO IS : 1570 (PART 1)-1978]

(First Revision)

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PART 1 STEELS SPECIFIED BY TENSILE AND/OR YIELD PROPERTIES [COMPLEMENTARY TO IS : 1570 (PART 1)-1978]

(*First Revision*)

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COMMENTARY ON INDIAN STANDARD SCHEDULES FOR WROUGHT STEELS

PART 1 STEELS SPECIFIED BY TENSILE AND/OR YIELD PROPERTIES [COMPLEMENTARY TO IS : 1570 (PART 1)-1978]

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part 1) (First Revision) was adopted by the Bureau of Indian Standards on 25 May 1987, after the draft finalized by the Alloy Steels and Special Steels Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Commentary on Indian Standard wrought steels for general engineering purposes was first published in 1965 as complementary to IS: 1570-1961*.

0.3 With the revision IS : 1570 into different parts, it was felt necessary to revise IS : 1871-1965†.

0.4 The following modifications have been made in this revision:

a) Steel designations have been modified in accordance with IS : 1762 (Part 1)-1974‡. However, for the sake of easy identification, old designations are also given within bracket.

b) The various grades deleted or added in the revision of IS : 1570 (Part 1)-1978§ have been taken care of.

0.5 This part covers steels specified by tensile and/or yield properties.

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*Schedules for wrought steels for general engineering purposes (*first revision*).

†Commentary on Indian standard schedules for wrought steels for general engineering purposes.

‡Code for designation of steels: Part 1 Based on letter (*first revision*).

§Schedules for wrought steels: Part 1 Steels specified by tensile and/or yield properties.

0.6 Other parts in this series are as follows:

a) Carbon steels with specified chemical composition and related mechanical properties;

b) Carbon and carbon manganese free cutting steels;

c) Alloys steels including carbon steels for hardening and tempering, and case heardening;

d) High alloy steels, and stainless and heat resisting steels including valve steels;

e) Carbon and alloy tool steels; and

f) Creep resisting steels.

1. SCOPE

1.1 This commentary (Part 1) covers the standard steels given in IS : 1570 (Part 1)-1978*.

1.1.1 Typical uses of the steels covered here are given in Appendix A.

1.2 These steels (*see* Table 1) are specified on the basis of their tensile and/or yield properties. Each grade of steel has been subdivided into two subgrades, one with a low yield to tensile ratio and the other with a high yield to tensile ratio.

2. Steels specified in Table 1 are put into service in the hot-rolled, normalized or annealed condition.

2.1 For special applications, restricted ranges of tensile and yield strength may be specified subject to mutual agreement between the supplier and the purchaser.

2.1.1 Fe 540 to Fe 690 are medium tensile structural steels. High tensile steels Fe 770 and Fe 870 are employed for heavy duty applications.

2.2 The designer should have sufficient appreciation of the properties of these steels enable him not only to select the material most suitable for any particular part, but also to arrive at such a disposition, shape and proportioning of the part so that good and economic use of the material

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*Code of designation for steels: Part 1 Based on letter symbols (*first revision*).

TABLE 1 TENSILE AND YIELD PROPERTIES OF STANDARD STEELS

(*Clause* 1.2)

STEEL DESIGNATION		TENSILE STRENGTH MPa* *Min*	YIELD STRENGTH MPa* *Min*	PERCENT ELONGATION $GL = 5{\cdot}65\sqrt{A}$ *Min*
New	Old			
Fe 290	(St 30)	290	170	27
FeE 220		290	220	27
Fe 310	(St 32)	310	180	26
FeE 230		310	230	26
Fe 330	(St 34)	330	200	26
FeE 250		330	250	26
Fe 360	(St 37)	360	220	25
FeE 270		360	270	25
Fe 410	(St 42)	410	250	23
FeE 310		410	310	23
Fe 490	(St 50)	490	290	21
FeE 370		490	370	21
Fe 540	(St 55)	540	320	20
FeE 400		540	400	20
Fe 620	(St 63)	620	380	15
FeE 460		620	460	15
Fe 690	(St 70)	690	410	12
FeE 520		690	520	12
Fe 770	(St 78)	770	460	10
FeE 580		770	580	10
Fe 870	(St 88)	870	520	8
FeE 650		870	650	8

*1 MPa = 1 N/mm^2 = 0·102 kgf/mm^2.

is made. The tensile strength and yield strength are usually the basis of design. The percentage elongation serves as an indication of the ductility of the material. It, however, does not necessary to indicate whether the failure of a structure will occur in ductile or brittle fashion; other tests, such as impact transition temperature, are essential to predict the nature of failure of a structure. Where stress to be withstood can be determined with reasonable accuracy, it is possible to design with safety to quite high working stresses and make the best use of steels. The greater the possibility of shock and local deformation, the more important it is to provide toughness and since, in general, ductility and toughness decrease as hardness and tensile strength increase, the choice of tensile properties to be specified in a given part is usually a compromise.

2.3 For design the majority of components fall into one of the two categories, namely, static and dynamic loading.

2.3.1 In the case of parts subjected to static loading, the yield strength is taken as the basis of design and it is usual to apply a factor of safety.

2.3.2 For dynamic loading the position is slightly different as working stresses should be related to the fatigue limit. Therefore, under fatigue conditions, it is necessary to pay special attention to surface conditions (good finish, removal of decarburization, etc) and to certain design features (the avoidance as sharp fillets, abrupt changes of sections, deep or sharp cornered keyways, etc). Further more, high tensile steels are more notch sensitive than low tensile steels and comparison of different notch impact values should be made only between same class of materials.

2.4 A certain heterogeneity within the mass of steel has also to be recognized. Efforts are made to keep this to a minimum, but the difficulties increase with the size of the ingot. In addition, there are directional differences, the ductility measured across the direction of working in wrought steels being appreciably lower than that in the longitudinal direction. This feature should be recognized both in the mechanical test requirements and in the design of parts. Special attention is directed to the fact that the elongation values given in Table 1 are for tests in the rolling direction.

2.5 Any tests, additional to the tensile and impact for example, bend test, dump test for rivet bars, flattening test on tubes, Erichson cupping tests on deep drawing steel, should also be specified, when necessary. In case of some structural steels, where the composition is adjusted to ensure a yield ratio higher than 55 percent of the tensile strength, the specification should be evolved on the basis of FeE grade steels.

2.6 For these steels, it is not usual to specify a detailed chemical composition, provided the specified tensile properties have been achieved. The quality of metal is, however, controlled when desired, by stipulating the maximum permissible percentage of carbon, sulpur and phosphorus. Wherever the high yield/tensile stress ratio steels are demanded, the composition may have to be adjusted or microalloy additions (Nb, V, Ti) may be required. Where resistance to corrosion is desired, copper content may be specified.

2.6.1 For special service requirements, such as weldability, it is desirable to limit the percentage of carbon. In general, a low carbon steel is more easily weldable than a high carbon steel.

The higher carbon content tends to harden the weld joints as a result of which the weld is susceptible to cracks. For ease in welding a maximum carbon equivalent is specified and the carbon content is limited usually below 0·22 percent. While choosing a steel, the designer has to keep in mind the thickness of the plate or section and the desired mechanical properties as obtained by adjustment of carbon and manganese contents.

2.6.2 Sulphur induces hot shortness, if manganese is insufficient; the sulphides segregate in vital areas, adversely affecting the ductility and impact strength of steel. Further sulphide inclusions get elongated in the direction of strain, especially in hot working and give rise to sulphide stringers raising anisotropy in steel. Ductility and toughness are greatly reduced across the working direction depending upon the inclusion content and amount of working. The treatment of steel with hard and less plastic sulphide forming elements like Ce, Ti, Zr, etc, are increasingly being practiced to reduce the anisotropism. High sulphur increases the tendency of steel to corrode. However, in free cutting steels, sulphur is intentionally added up to 0·3 percent to increase the machinability, although other properties get adversely affected.

2.6.3 Phosphorus in small amount dissolves in ferrite and increases the strength. However, the higher amounts render the steel cold short and lowers its resistance to shock and impact loading. This is more marked in high carbon steels than low carbon steels.

2.6.4 In some structural steels, certain amount of copper is found to be beneficial for increasing resistance to corrosion and also strength in such cases it is specified. The copper bearing steels containing about 0·25 percent copper are well known and are widely used for structural purposes. Phosphorus also improves the atmospheric corrosion resistance to steel and steels containing copper and phosphorus along with other alloying elements have been developed for improved weather resistance properties.

2.7 Where necessary, the type of steel (killed, semi-killed or rimmed) should also be specified. All forging steels and, in general, all steels containing more than 0·25 percent carbon are killed; structural steels containing 0·15-0·25 percent carbon are generally semi-killed; and steels with less than 0·15 percent carbon are usually rimmed.

2.7.1 In forging steels and other high carbon steels, which are normally fully killed, the essential quality is soundness in terms of freedom from internal cavities and reduced segregation. When the steel is deoxidized sufficiently, there is no evolution of gas and top surface of ingot solidifies almost immediately loading to pipe formation at the top of the ingots. This renders yield loss in the ingots and, for this reason, killed steels are generally poured in the ingot moulds with hot top.

2.7.2 In semi-killed steel, the aim is to produce metal free from surface blow holes and pipe. The surface should have a sound skin of considerable thickness. Plates and structural products normally made from semi-killed steel.

2.7.3 In rimmed steel the aim is to produce a clean surface low in carbon content. In rimming, the steel is partially deoxidized. A wide variety of steels for deep drawing is made by the rimming process, especially where ease of forming and surface finish are major considerations.

APPENDIX A

(*Clause* 1.1.1)

TYPICAL USES OF INDIAN STANDARD STEELS

A-1. STEELS SPECIFIED BY TENSILE PROPERTIES BUT WITHOUT DETALED CHEMICAL COMPOSITION

Steel Designation	*Typical Uses*
Fe 290 and FeE 220	Structural steel sheets for plain drawn or enamelled parts, tubes for oil well casing, steam, water and air passage, cycle, motor-cycle and automobile tubes, rivet bars and wire
Fe 310 and FeE 230 Fe 230 and FeE 250	Steels for locomotive, carriage and car structures, screw stock, and other general engineering purposes
Fe 360 and FeE 270	Structural steel for chemical pressure vessels and other general engineering purposes
Fe 410 and FeE 310	Structural steel for bridges and building construction, railway rolling stock, screw spikes, oil well casing, tube piles, and other general engineering purposes

Fe 490 and FeE 370	Structural steel for mines, forgings for marine engines, sheet piling and machine parts
Fe 540 and FeE 400	High tensile steel for locomotive, carriage, wagon and tramway axles, arches for mines, bolts, and seamless and welded tubes
Fe 620 and FeE 460	High tensile steel for tramway axles and seamless tubes
Fe 770 and FeE 580	High tensile steel for locomotive, carriage and wagon wheels and tyres, and machine parts for heavy loading
Fe 870 and FeE 650	High tensile steel for locomotive, carriage and wagon wheels and tyres

(*Continued from page* 2)

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